CERTIFICATE OF VERIFICATION

I, Soo Jin KIM of 648-23 Yeoksam-dong, Gangnam-gu, Seoul, Republic of Korea state that the attached document is a true and complete translation to the best of my knowledge of the Korean-English language and that the writings contained in the following pages are correct English translation of the specification and claims of the Korean Patent Application No. 10-1999-0014239.

Dated this 30th day of January, 2007.

Signature of translator: ______________________

Soo Jin KIM

[Translation] P1999-14239

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Application Number : Patent Application No. 1999-14239

Date of Application : Apr 21, 1999

Applicant(s) : LG Electronics Inc.

COMMISIONER

[SPECIFICATION]

[TITLE OF THE INVENTION]

METHOD AND APPARATUS FOR RECORDING/REPRODUCING OF OPTICAL RECORDING MEDIUM

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a diagram showing an arrangement of a header preformatted at the beginning position of each sector in a general rewritable disc.

FIG. 2 is a block diagram showing a structure of an optical disc recording/reproducing apparatus for controlling defocus in accordance with the present invention.

FIG. 3 is an exemplary diagram showing an optical detector of the optical pickup shown in FIG. 2.

FIG. 4 is an exemplary graph showing read channel 2 signals detected at VFO1 and VFO3 areas in the header field depending on variation of a defocus offset.

FIGS. 5a to 5c are diagrams showing level variation of read channel 2 signals detected at VFO1 and VFO3 areas in the header field depending on variation of defocus offset.

FIG. 6 is an exemplary graph showing read channel 1 signals detected at VFO1 and VFO3 areas in the header field depending on variation of a defocus offset.

FIGS. 7a to 7c are diagrams showing level variation

of read channel 1 signals detected at VFO1 and VFO3 areas in the header field depending on variation of defocus offset.

FIG. 8(a) is a graph showing a result of VFO1 to VFO3 of read channel 1 detected in FIG. 6.

FIG. 8(b) is a graph showing a result of VFO1 to VFO3 of read channel 2 detected in FIG. 4.

Reference numerals of the essential parts in the drawings

201 : optical disc

202 : optical pickup

203 : RF signal and servo error signal generator

204 : defocus detector

205 : servo controller

206 : focus operator

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND DISCUSSION OF THE RELATED ART]

The present invention relates to a high-density optical recording medium system, and more particularly, to an apparatus and method for recording/reproducing of optical recording medium, capable of detecting and compensating for defocus of the optical recording medium.

In general, an optical recording medium is divided into a ROM-type for read-only, a WORM-type for rewritable only one time, and a rewritable-type for recording repetitively.

Among them, a repetitively and freely rewritable optical recording medium, for example, an optical disc includes rewritable compact disc (CD-RW) and rewritable digital versatile disc (DVD-RW, DVD-RAM).

These rewritable optical mediums, particularly, DVD-RAMs have signal tracks made up of lands and grooves and enable the tracking control of an empty disc on which no information signal is written. Recently, information signals are also written on the tracks of lands and grooves so as to enhance recording density. For this purpose, the recent optical pickup for recording and reproducing information signals uses the shorter wavelength of laser beam with an increased number of apertures formed in the object lens and thereby reduces the size of beam for recording/reproducing.

In order to achieve higher recording density, such a rewritable high-density optical disc is designed to have a reduced distance between the signal tracks, i.e., the smaller signal track pitch.

For the rewritable discs, it is naturally impossible to perform a disc control and a recording

operation in an empty disc in which no information is written. Thus disc tracks are formed in lands and grooves to write information on, and control information for random access and rotation control is separately recorded in the disc, so as to enable tracking control in the empty disc.

The control information is, as shown in FIG. 1, written on the header pre-formatted at the beginning position of each sector, or along the track in the wobbling profile. The term "wobbling" as used herein refers to recording the control information on the boundary of tracks in accord to variation of laser beam by supplying power of laser diodes with information for modulating a predetermined clock and applying the modulated clock to the disc, e.g., information about a desired position and the rotational speed of the disc.

The header preformatted at the beginning position of each sector includes four header fields (header 1 field, header 2 field, header 3 field and header 4 field). Each header field has variable frequency oscillator (VFO) areas for generating a reference clock to acquire bit synchronization of read channels. In the present invention, the VFO areas present in the respective header fields (header 1 field ~ header 4 field) are called VFO1 ~ VFO4.

That is, VFO1 and VFO 3 areas are present in the

header 1 field and the header 3 field, VFO2 and VFO4 areas being in the header 2 field and the header 4 field. The VFO1 and VFO3 areas are longer and more stable for signal detection than the VFO2 and VFO4 areas.

At this time, the four header fields are staggered with respect to each other from the track center. FIG. 1 shows an example of the header for the first sector in a track. Referring to FIG. 1, the track boundary of the user area in which data are actually written has a wobbling profile.

An optical record reproducing apparatus also performs focus controls with an optical pickup in recording and reproducing information.

In a case where the beam focus is deflected from the disc surface during a focus control, i.e., focus servo, which case will be referred to as "defocus" hereinafter, quality of data deteriorates in recording and reproducing the data and thereby the system operation becomes unstable.

The focus servo drives a focus actuator in the optical pickup to move the optical pickup up or down and make the beam in focus according to the turning and up-and-down motions of the optical disc. That is, the focus actuator drives the object lens for convergence of beam in the upward/downward direction, e.g., in a direction of the focus axis to maintain a constant distance between the

object lens and the optical disc.

However, in the optical discs such as DVD-RAM where data can be written in both lands and grooves, the lands and grooves differ in the focus offset from each other due to a depth difference and cause defocus even when no focus error signal is detected.

That is, due to the depth difference between the lands and grooves, defocus may be detected in the tracks of the grooves even when the focus meets in the tracks of the lands. Likewise, defocus may be detected in the tracks of the lands even when the focus meets in the tracks of the grooves because of the depth difference between the land and grooves.

[TECHNICAL TASKS TO BE ACHIEVED BY THE INVENTION]

At the defocus status cannot be known only from the focus error signals in this case, jitter characteristic deteriorates and the bit error rate (BER) increases. Recording data in this state may result in change recording characteristics of lands and grooves and hence deterioration of data quality, which makes the system operation unstable.

Accordingly, the present invention is directed an apparatus and method for recording/reproducing of optical recording medium that substantially obviates one or more

problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide an apparatus and method for recording/reproducing of optical recording medium, capable of detecting and compensating for defocus from header areas staggered with respect to each other.

[SYSTEM AND OPERATION OF THE INVENTION]

To achieve the above objects of the present invention, when recording/reproducing a disc arranging a plurality of sections being difference in phase for dividing shape of data area between writable data areas and having non-writable areas repetitively/alternately and sequentially including position information of disc of the data area in each section, a method for recording/reproducing of an optical recording medium includes the steps of: obtaining a difference signal between signals outputted from a section having difference phase each other within the non-writable area; determining as defocus if the difference signal exceeds the definite reference range and outputting the resulting value; and performing a focus servo from the resulting value.

The step for obtaining the difference signal uses only prescribed part of the non-writable area.

The step for obtaining the difference signal uses VFO area of the non-writable area.

The step for obtaining the difference signal uses a sum signal of electrical signals proportionate to quantity of reflex light detected based on the direction of the track.

The step for obtaining the difference signal uses a subtract signal of electrical signals proportionate to quantity of reflex light detected based on the direction of the track.

The defocus detecting step determines as "focus-on" if the difference signal is in the prescribed reference range and outputs the resulting value.

The defocus detecting step determines as "focus-on" if the sum signal of signals outputted from a section having different phase in the non-writable area is maximum and outputs the resulting value.

The defocus performing step further includes a step of detecting the direction of defocus from the sign of the difference signal.

When recording/reproducing an optical recording medium arranging 1 and 2 headers being difference in phase for dividing shape of data area between writable data areas, a method for recording/reproducing of an optical recording medium includes the steps of: determining

defocus by variation value between two signals detected from the 1 and 2 headers, respectively and outputting the resulting value; and performing a focus servo by compensating defocus from the resulting value.

The defocus detecting step determines defocus by variation value of signals detected from VFO areas of the 1 header and 2 header.

The defocus detecting step determines defocus by variation value of read channel 2 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

The defocus detecting step determines defocus by variation value of read channel 1 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

The defocus detecting step includes the steps of: detecting a read channel 1 signal and a read channel 2 signal in VFO1 and VFO3, respectively; setting an area that both the read channel 1 signal and read channel 2 signal are changed proportionally as an active area; determining as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 exceeds the preset reference value; determining as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 does not exceed the preset

reference value and is an inactive area; and determining as "focus-on" if a difference signal of the read channel 1 signals detected from the 1 and 2 header does not exceed the preset reference value and is an active area.

When recording/reproducing an optical recording medium arranging 1 and 2 headers being difference in phase for dividing shape of data area between writable data areas, an apparatus for recording/reproducing of an optical recording medium includes: a servo error generator for detecting a read channel 1 signal and a read channel 2 signal from electric signals outputted in proportion to quantity of light reflected from the 1 and 2 header of the optical recording medium; a defocus detector for detecting defocus by using at least any one between variation value of the read channel 1 signal and read channel 2 signal detected from the 1 and 2 header, respectively; and a focus servo for compensating defocus detected from the defocus detector and operating a focus actuator.

The defocus detector detects defocus by variation value of read channel 2 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

The defocus detector detects defocus by variation value of read channel 1 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a

header 3 field in the 2 header.

The defocus detector sets an area that both the read channel 1 signal and read channel 2 signal are changed proportionally as an active area and determines as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 exceeds the preset reference value.

The defocus detector determines as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 does not exceed the preset reference value and is an inactive area.

The defocus detector determines as "focus-on" if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 does not exceed the preset reference value and is an active area.

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

The present invention is directed to compensation of defocus by detecting a magnitude and direction of defocus using variation of a read channel 1 and read channel 2 detected from header fields, especially, header 1 and 3 fields, staggered on the basis of track sectors.

FIG. 2 is a block diagram showing the structure of an optical disc recording/reproducing apparatus for

performing defocus control method according to the present invention, in which only the principal parts related to focus are shown.

Referring to FIG. 2, the optical disc recording/reproducing apparatus includes: a rewritable optical disc (201); an optical pickup (202) for recording/reproducing information on the optical disc (201); an RF and servo error signal generator (203) for generating signals such as a read channel 1 and read channel 2 from electrical signals output from the optical pickup (202); a defocus detector (204) for detecting a magnitude and the direction of defocus from the read channel 1 or read channel 2 of the RF and servo error generator (203); a servo controller (205) for generating a focus driving signal from the magnitude and the direction of defocus detected from the defocus detector (204); and a focus driver (206) for controlling the optical pickup (202) based on the focus driving signal to compensate for the defocus.

Herein, the optical pickup (202) has a split photo detector for detecting the quantity of light and converting the detected quantity of light to electrical signals. The split photo detector can be divided, as shown in FIG. 3, into a predefined number of optical detecting elements, e.g., four optical detecting elements PDA, PDB,

PDC and PDD in the signal track direction and the radial direction of the optical disc (201).

In the present invention as constructed above, the optical disc (201) has signal tracks made up of lands and grooves, and data can be recorded/reproduced on the tracks of both the lands and the grooves as well as either the land tracks or the groove tracks. Also, at the beginning position of each sector, header 1 and 2 fields and header 3 and 4 fields are staggered with respect to each other in a free format. That is, the phases of the header 1 and 2 fields are in inverse relation with those of the header 3 and 4 fields.

Thus, while setting the optical disc (201), or during the recording/reproducing operation, the laser beam emitted from a laser diode of the optical pickup (202) is directed onto the signal tracks of the optical disc (201) and the beam reflected from the signal tracks of the optical disc (201) enters the split photo detector.

The split photo detector includes a plurality of optical detecting elements and outputs to the RF and servo error signal generator (203) electrical signal proportional to the quantity of beam obtained from the respective optical detecting elements.

The optical detector, if constructed as shown in FIG. 3, outputs to the RF and servo error signal generator

(203) electrical signals a, b, c and d, each in proportion to the quantity of beam obtained from the respective optical detecting elements PDA, PDB, PDC and PDD.

The RF and servo error signal generator (203) combines the electrical signals a, b, c and d to generate a read channel 1 signal (or an RF signal) necessary for data reading, and a read channel 2 signal and a focus error signal, which are all necessary for a servo control. The read channel 1 signal is obtained by combining the electrical signals a, b, c and d from the split optical detector as a+b+c+d, and the read channel 2 signal is obtained by combining the electrical signals as (a+d)-(b+c). The tracking error signal is obtained by processing the read channel 2 signal through filtering.

The split photo detector, if divided into two photodiodes (I1 and I2) in the direction of tracks, detects the read channel 1 signal (=I1+I2) and the read channel 2 signal (=I1-I2) from the beam quantity balance of both photodiodes. That is, in FIG. 3, a+d corresponds to I1 and b+c corresponds to I2.

The present invention detects defocus from variations of VFO1 and VFO3 signals in the header field. Here, the header field is used because of similarity of land and groove characteristics, and the reason for using signals of VFO1 and VFO3 areas in the header field lies in

that the VFO1 and VFO3 areas are the longest and most stable areas in the header field and easy to detect.

At this time, the present invention may use a read channel 1 signal of the header field for detecting the defocus, or both read channel 1 signal and read channel 2 signal may be used. Using the read channel 1 signal will be described in a first embodiment and using the read channel 2 signal will be described in a second embodiment.

First Embodiment

The first embodiment of the present invention is to detect the magnitude and the direction of defocus from variations of read channel 2 signals detected at VFO1 and VFO3 areas in the header field. For this, read channel 2 signals among the error signals detected at the RF and servo error signal generator (203) are input to the defocus detector (204). The defocus detector (204) detects the levels of the read channel 1 signals, i.e., peak-to-peak voltages (V_{PP}) to determine presence of defocus.

The following Table 1 shows read channel 2 signals detected at VFO1 and VFO3 areas with track on after controlling defocus and detrack at tile=0 (i.e., mechanism=0) for obtaining highest and planarized tracking error signals, in which the read channels 2 signal level at VFO1 and VFO3 areas are changed due to variation of a

defocus offset with fixed tilt and detrack offsets.

[Table 1]

Defocus [ ]	VFO1 [V]	VFO3 [V]
00.00		
1.00		
2.00	0.142	0.087
3.00	0.178	0.151
4.08	0.192	0.199
5.00	0.162	0.201
6.00	0.119	0.181
7.00	0.064	0.139
8.00	0.021	0.089
9.00		
10.00		

FIG. 4 is a graph illustrating Table 1, in which no defocus is detected at highest voltage levels V_{PP} of VFO1 and VFO3 signals and the direction of defocus is detected from the sign of VFO1-VFO3.

That is, detection of defocus is based on the principle that variations of read channel 2 signals at VFO1 and VFO3 areas in the header field, e.g., peak-to-peak levels depend on the degree of defocus.

In no defocus has occurred, i.e., "on-focus", then VFO1-VFO3≈0 and VFO1+VFO3=maximum, where VFO1 and VFO3 are peak-to-peak voltages of read channel 2 signals detected at VFO1 and VFO3 areas. No defocus is also detected when VFO1-VFO3<V_{Th1}, where V_{Th1} is a predetermined threshold

value, instead of VFO1-VFO3≈0.

Otherwise, if defocus has occurred, then VFO1-VFO3= + or - (the sign of the difference value depends on the direction of defocus) and VFO1+VFO3≠maximum. Defocus is also detected when VFO1-VFO3>V_{Th1}, where V_{Th1} is a predetermined threshold value. The direction of defocus is known from the sign of VFO1-VFO3.

Referring to Table 1 or FIG. 4, at defocus offset 4.08, VFO1-VFO3≈0, VFO1+VFO3=maximum and the curve has an inflection. That is, the value VFO1-VFO3 is varying in one direction (e.g., successively increasing or decreasing) on the basis of defocus offset 4.08, which facilitates signal detection.

FIGS. 5a to 5c are exemplary diagrams showing the level variation of the read channel 2 signals detected at a variable defocus offset under the same conditions as Table 1.

Referring to FIGS. 5a to 5c, the value VFO1+VFO3 is at maximum in FIG. 5b, which means that no defocus has occurred. And, defocus is detected in FIGS. 5a and 5c.

If the value VFO1-VFO3 is α and the absolute value of α is larger than the threshold V_{Th1} or the value VFO1+VFO3 is not maximum, then compensation for defocus has to be performed in the positive(+)/negative(-)

direction when the sign of α is negative(-)/positive(+).

As the values VFO1 and VFO3 are variable depending on the disc, the ratio of the two signals is normalized as experessed by Equation 1.

[Equation 1]

$$\frac{VFO1 - VFO3}{VFO1 + VFO3} < V_{Th1}$$

If Equation 1 is satisfied, it is determined that no defocus has occurred. Otherwise, if Equation 1 is not satisfied, it is determined that focus has occurred, and magnitude and the direction of defocus are detected from the absolute value and the sign of the difference (VFO1-VFO3), respectively.

Hence, the defocus detector (204) outputs to the servo controller (205) defocus error signals indicating the magnitude and the direction of defocus detected in the above process. The servo controller (205) converts the defocus error signals to a focus driving signal and outputs the focus driving signal to the focus driver (206).

The focus driver (206) drives a focus actuator in the optical pickup based on the focus driving signal, i.e., moves the optical pickup by the magnitude of defocus in the positive (+) or negative (-) direction such that the

object lens is separated from the optical disc at a constant distance.

Second Embodiment

Meanwhile, the second embodiment of the present invention is to detect defocus from variation of read channel 1 signals at VFO1 and VFO3 areas in the header field and the magnitude and the direction of defocus are detected from variation of read channel 2 signals.

For this purpose, among the error signals detected at the RF and servo error signal generator (@03), both read channel 1 signals and read channel 2 signals are input to the defocus detector (204). The defocus detector (204) detects the levels of the read channel 1 signals, i.e., peak-to-peak voltages (V_{PP}) to determine presence of defocus.

In this instance, the following Table 2 shows read channel 1 signals detected at VFO1 and VFO3 areas with track on after controlling defocus and detrack at tilt=0 (i.e.,mechanism=0) for obtaining highest and planarized tracking error signals, in which the read channel 1 signal levels at VFO1 and VFO3 areas are changed due to fariation of a defocus offset with fixed tilt and detrack offsets.

[Table 2]

Defocus [ ]	VFO1 [V]	VFO3 [V]
0.00		
1.00		
2.00	0.126	0.137
3.00	0.162	0.185
4.08	0.192	0.187
5.00	0.206	0.183
6.00	0.176	0.153
7.00	0.121	0.114
8.00	0.069	0.073
9.00		
10.00		

FIG. 6 is a graph illustrating Table 2, in which no defocus is detected at highest voltage levels V_{pp} at VFO1 and VFO3 areas, and the magnitude and the direction of defocus are detected from the result of VFO1-VFO3.

That is, detection of defocus is based on the principle that variations of read channel 1 signals at VFO1 and VFO3 areas in the header field, e.g., peak-to-peak levels depend on the degree of defocus.

If no defocus has occurred, i.e., "on-focus", then VF"O1-VFO3 ≈ 0 and VFO1+VFO3=maximum, where VFO1 and VFO3 are peak-to-peak voltages of read channel 1 signals detected at VFO1 and VFO3 areas.

In this instance, no defocus is also detected when

VFO1+VFO3=maximum and VFO1-VFO3<V_{Th2}, where V_{Th2} is a predetermined threshold value, instead of VFO1-VFO3≈0.

Otherwise, if defocus has occurred, then VFO1-VFO3 = + or - (the sign of the difference value depends on the direction of defocus) and VFO1+VFO3≠maximum. Defocus is also detected when VFO1-VFO3>V_{Th2}, the direction of defocus being known from the sign of VFO1-VFO3.

Referring to Table 2 or FIG. 6, at defocus offset 4.08, VFO1-VFO3≈0, VFO1+VFO3=maximum.

For read channel 1 signals, it is necessary to define an active area in order to acquire accurate detection of defocus because there are many cases where VFO1-VFO3<V_{Th2}, as shown in FIG. 6.

FIG. 8(a) shows the value of VFO1-VFO3 for read channel 1 signals and FIG. 8(b) shows the value of VFO1-VFO3 for read channel 2 signals.

Referring to the value of VFO1-VFO3, when no defocus has occurred, i.e., near the defocus offset of 4.08, read channel 1 signals and read channel 2 signals are both changed greatly. After the defocus offset of 4.08, VFO1-VFO3 for read channel 1 signals decreased but VFO1-VFO3 for read channel 2 signals is constant.

Thus the active area can be defined as an interval where both VFO1-VFO3 for read channel signals and read channel 2 signals change proportionally.

FIGS. 7a to 7c are exemplary diagrams showing the level variation of the read channel 1 signals detected at a variable defocus offset under the same conditions as Table 2.

Referring to 7a to 7c, the difference value VFO1-VFO3 approaches zero in all cases and the sum VFO1+VFO3 is at maximum in FIG. 7b. Thus defocus is detected in FIG. 7a and 7c, no defocus being detected in FIG. 7b. That means, it is determined that defocus has occurred in FIGS. 7a and 7c, where the difference value VFO1-VFO3 approaches zero in both cases and the non-active area is defined.

Therefore, if the value VFO1-VFO3 is β and the absolute value of β is larger than the threshold V_{Th2}, then compensation for defocus has to be performed in the positive(+)/negative(-) direction when the sign of β is negative(-)/positive(+). The magnitude of defocus can be measured as the size of the active area.

As the values VFO1 and VFO3 are variable depending on the disc, the ratio of the two signals is normalized as expressed by Equation 2.

[Equation 2]

$$\frac{VFO1 - VFO3}{VFO1 + VFO3} < V_{Th2}$$

If Equation 2 is satisfied, it is determined no defocus has occurred. Otherwise, if Equation 2 is not satisfied, it is determined that focus has occurred. The direction of defocus is detected from the sign of VFO1-VFO3, the magnitude of defocus being detected from the size of the active area detected using both the read channel and the read channel 2.

In connection with this, the defocus detector (204) outputs to the servo controller (205) defocus error signals indicating the direction of defocus detected in the above process. The servo controller (205) converts the defocus error signals to a focus driving signal and outputs the focus driving signal to the focus driver (206).

The focus driver (206) drives a focus actuator in the optical pickup based on the focus driving signal. i.e., moves the optical pickup in the positive (+) or negative (-) direction such that the object lens is separated from the optical disc at a constant distance.

As such, the present invention can detect the magnitude and the direction of defocus and compensate for them using read channel 1 signals or read channel 2 signals detected at VFO1 and VFO3 areas in the header field.

The system, the present invention checks defocus at a plurality of header fields predefined during

initialization of the system in the above-stated way and memories the magnitude and the direction of defocus at the corresponding position. Thus the present invention can compensate for defocus according to the previously detected magnitude and direction of defocus at the corresponding position during an actual data recording/reproducing operation and thereby rapidly stabilize focus servo.

Furthermore, the present invention capable of real-time feedback can detect defocus with all servo offsets, e.g., tracking and focus servo on and immediately compensate for defocus during an actual data recording/reproducing operation.

[EFFECT OF THE INVENTION]

As described above, according to an apparatus and method for recording/reproducing of optical recording medium, since the magnitude of a read channel 1 signal or read channel 2 signal detected in a header field staged with respect to each other from a track center varies in accord with defocus offset, by using this characteristic, defocus is detected and compensated, thereby preventing deterioration of data quality caused by defocus during a recording/reproducing operation, enabling rapid stabilization of focus servo, and operating the system

stably.

It will be apparent to those skilled in the art than various modifications and variations can be made in the present invention.

Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is :

1. In a method for recording/reproducing a disc arranging a plurality of sections being difference in phase for dividing shape of data area between writable data areas and having non-writable areas repetitively/alternately and sequentially including position information of disc of the data area in each section,

a method for recording/reproducing of an optical recording medium including the steps of:

obtaining a difference signal between signals outputted from a section having difference phase each other within the non-writable area;

determining as defocus if the difference signal exceeds the definite reference range and outputting the resulting value; and

performing a focus servo from the resulting value.

2. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the step for obtaining the difference signal uses only prescribed part of the non-writable area.

3. A method for recording/reproducing of an optical

recording medium as claimed in claim 2, wherein the step for obtaining the difference signal uses VFO area of the non-writable area.

4. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the step for obtaining the difference signal uses a read channel 1 signal which is sum of electrical signals proportionate to quantity of reflex light detected based on the direction of the track.

5. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the step for obtaining the difference signal uses a read channel 2 signal which is subtract of electrical signals proportionate to quantity of reflex light detected based on the direction of the track.

6. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the step for obtaining the difference signal obtains the difference signal by fixing tilt and track offsets but changing defocus offset.

7. A method for recording/reproducing of an optical

recording medium as claimed in claim 1, wherein the defocus detecting step determines as "focus-on" if the difference signal is in the prescribed reference range and outputs the resulting value.

8. A method for recording/reproducing of an optical recording medium as claimed in claim 7, wherein the defocus detecting step determines as "focus-on" if the sum signal of signals outputted from a section having different phase in the non-writable area is maximum and outputs the resulting value.

9. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the defocus performing step further includes a step of detecting the direction of defocus from the sign of the difference signal.

10. A method for recording/reproducing of an optical recording medium as claimed in claim 3, wherein the step for obtaining the difference signal obtains a difference signal between two signals detected from VFO1 and VFO3 of a header 1 and header 3 field in the non-writable area.

11. A method for recording/reproducing of an optical recording medium as claimed in claim 9, wherein the focus servo step compensates defocus in order for the sum signal of two signals detected from areas having difference phase in the non-writable area to an opposite direction of the detected defocus to be the maximum.

12. A method for recording/reproducing of an optical recording medium as claimed in claim 1, wherein the defocus detecting step detects defocus by normalizing a difference of two signals (VFO1 and VFO3) detected from areas having difference phase in the non-writable area as shown in the followings.

$$\frac{VFO1-VFO3}{VFO1+VFO3}$$

13. In a method for recording/reproducing an optical recording medium arranging 1 and 2 headers being difference in phase for dividing shape of data area between writable data areas,

a method for recording/reproducing of an optical recording medium including the steps of:

determining defocus by variation value between two signals detected from the 1 and 2 headers, respectively and outputting the resulting value; and

performing a focus servo by compensating defocus from the resulting value.

14. A method for recording/reproducing of an optical recording medium as claimed in claim 13, wherein the defocus detecting step determines defocus by variation value of signals detected from VFO areas of the 1 header and 2 header.

15. A method for recording/reproducing of an optical recording medium as claimed in claim 14, wherein the defocus detecting step determines defocus by variation value of read channel 2 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

16. A method for recording/reproducing of an optical recording medium as claimed in claim 15, wherein the defocus detecting step detects the direction of defocus from the sign of a difference signal between two read channel 2 signals detected from the VFO1 and VFO3, respectively.

17. A method for recording/reproducing of an optical recording medium as claimed in claim 16, wherein

the focus servo step compensates defocus in order for the sum signal (VFO1+VFO3) of two read channel 2 signals detected from VFO1 and VFO3 areas to an opposite direction of the detected defocus to be the maximum.

18. A method for recording/reproducing of an optical recording medium as claimed in claim 14, wherein the defocus detecting step determines defocus by variation value of read channel 1 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

19. A method for recording/reproducing of an optical recording medium as claimed in claim 18, wherein the defocus detecting step including the steps of:

detecting a read channel 1 signal and a read channel 2 signal in VFO1 and VFO3, respectively;

setting an area that both the read channel 1 signal and read channel 2 signal are changed proportionally as an active area;

determining as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 exceeds the preset reference value;

determining as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3

does not exceed the preset reference value and is an inactive area; and

determining as "focus-on" if a difference signal of the read channel 1 signals detected from the 1 and 2 header does not exceed the preset reference value and is an active area.

20. A method for recording/reproducing of an optical recording medium as claimed in claim 19, wherein the defocus detecting step detects the direction of defocus from the sign of a difference signal between two read channel 1 signals detected from the VFO1 and VFO3, respectively.

21. A method for recording/reproducing of an optical recording medium as claimed in claim 13, wherein the defocus detecting step detects defocus by fixing tilt and track offsets.

22. A method for recording/reproducing of an optical recording medium as claimed in claim 13, wherein the defocus detecting step detects defocus by normalizing a difference of two signals (VFO1 and VFO3) detected from the 1 and 2 header as shown in the followings.

$$\frac{VFO1-VFO3}{VFO1+VFO3}$$

23. In an apparatus for recording/reproducing an optical recording medium arranging 1 and 2 headers being difference in phase for dividing shape of data area between writable data areas,

an apparatus for recording/reproducing of an optical recording medium including:

a servo error generator for detecting a read channel 1 signal and a read channel 2 signal from electric signals outputted in proportion to quantity of light reflected from the 1 and 2 header of the optical recording medium;

a defocus detector for detecting defocus by using at least any one between variation value of the read channel 1 signal and read channel 2 signal detected from the 1 and 2 header, respectively; and

a focus servo for compensating defocus detected from the defocus detector and operating a focus actuator.

24. An apparatus for recording/reproducing of an optical recording medium as claimed in claim 23, wherein the defocus detector detects defocus by using at least any one between variation value of the read channel 1 signal and read channel 2 signal detected from VFO areas of the 1 header and 2 header, respectively.

25. An apparatus for recording/reproducing of an optical recording medium as claimed in claim 24, wherein the defocus detector detects defocus by variation value of read channel 2 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

26. An apparatus for recording/reproducing of an optical recording medium as claimed in claim 25, wherein the focus servo detects the direction of defocus from the sign of a difference signal between two read channel 2 signals detected from the VFO1 and VFO3, respectively, and compensates defocus in order for the sum signal (VFO1+VFO3) of two read channel 2 signals to an opposite direction of the detected defocus to be the maximum.

27. An apparatus for recording/reproducing of an optical recording medium as claimed in claim 24, wherein the defocus detector detects defocus by variation value of read channel 1 signals detected between VFO1 area of a header 1 field in the 1 header and VFO3 area of a header 3 field in the 2 header.

28. An apparatus for recording/reproducing of an

optical recording medium as claimed in claim 27, wherein the defocus detector:

sets an area that both the read channel 1 signal and read channel 2 signal are changed proportionally as an active area;

determines as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 exceeds the preset reference value;

determines as defocus if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 does not exceed the preset reference value and is an inactive area; and

determines as "focus-on" if a difference signal of the read channel 1 signals detected from the VFO1 and VFO3 does not exceed the preset reference value and is an active area.

29. An apparatus for recording/reproducing of an optical recording medium as claimed in claim 28, wherein the focus servo detects the direction of defocus from the sign of a difference signal between two read channel 1 signals detected from the VFO1 and VFO3, respectively, and compensates defocus in order for the sum signal (VFO1+VFO3) of two read channel 1 signals to an opposite direction of the detected defocus to be the maximum.

30. A method for recording/reproducing of an optical recording medium as claimed in claim 23, wherein the defocus detecting step detects defocus by normalizing a difference of two signals (VFO1 and VFO3) detected from the 1 and 2 header as shown in the followings.

$$\frac{VFO1 - VFO3}{VFO1 + VFO3}$$

<도면부분>

track pitch

the outside

the inside

groove sector

land sector

header 1,2,3,4 field

mirror field

channel field

201 : disc

203 : RF and servo error generator

204 : defocus detector

205 : servo controller

206 : focus operator

defocus error

tilt, detrack offset, defocus offset

VFO1-VFO3 of read channel 1, 2

active area

[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

The present invention relates to an apparatus and method for recording/reproducing of optical recording medium. Since the magnitude of a read channel 1 signal or read channel 2 signal detected in a header field staged with respect to each other from a track center varies in accord with defocus offset, by using this characteristic, defocus is detected and compensated, thereby preventing deterioration of data quality caused by defocus during a recording/reproducing operation, enabling rapid stabilization of focus servo, and operating the system stably.

[TYPICAL DRAWING]

<tilt, detrack offset, defocus offset>

[INDEX WORDS]

defocus, read channel 1, read channel 2

FIG. 1

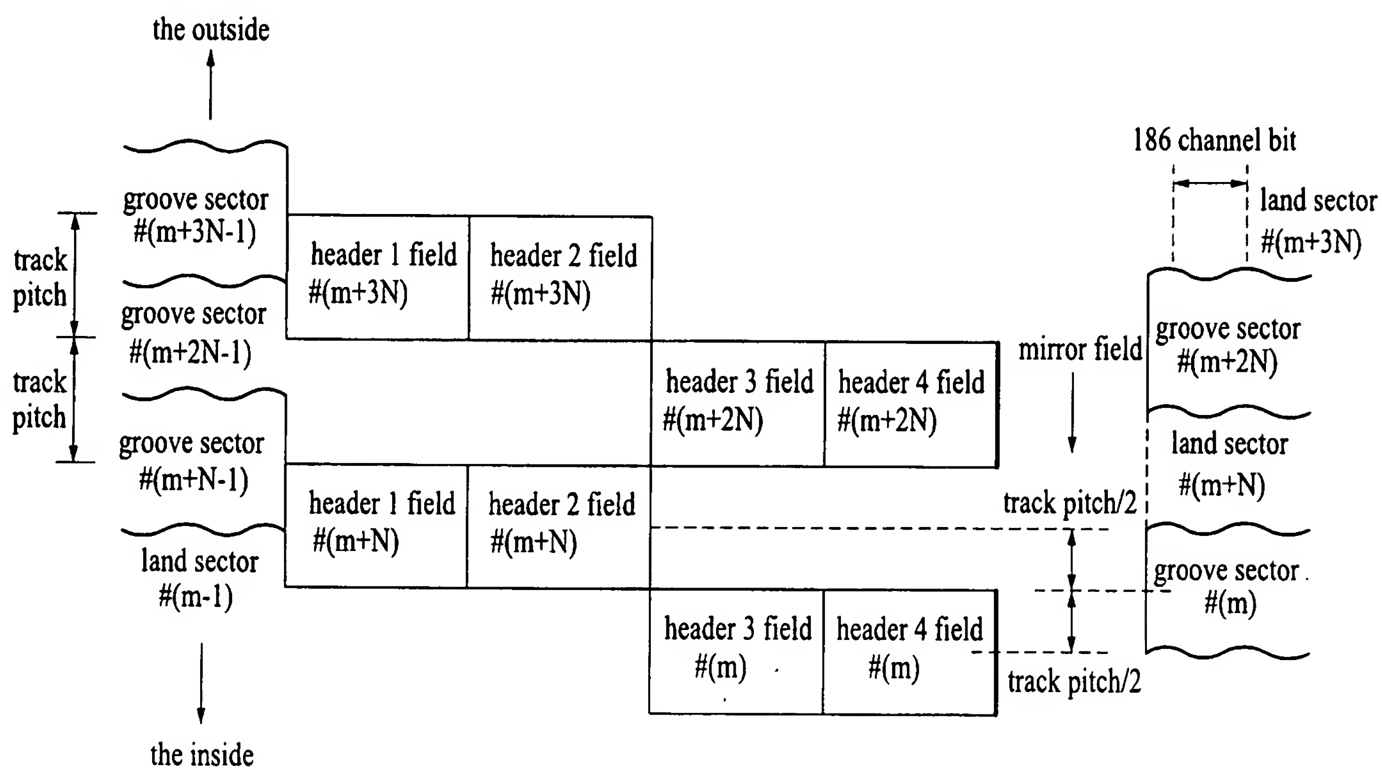

the outside
groove sector #(m+3N-1)
groove sector #(m+2N-1)
groove sector #(m+N-1)
land sector #(m-1)
the inside
track pitch
track pitch
header 1 field #(m+3N)
header 2 field #(m+3N)
header 3 field #(m+2N)
header 4 field #(m+2N)
header 1 field #(m+N)
header 2 field #(m+N)
header 3 field #(m)
header 4 field #(m)
mirror field
track pitch/2
track pitch/2
186 channel bit
land sector #(m+3N)
groove sector #(m+2N)
land sector #(m+N)
groove sector #(m)

FIG. 2

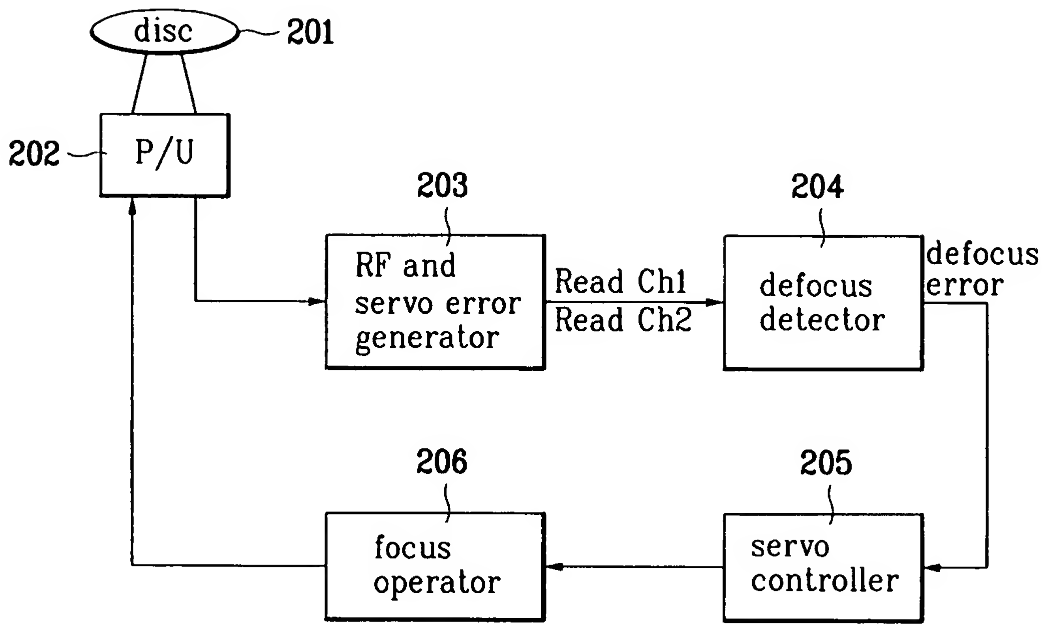

disc
201
202
P/U
203
RF and servo error generator
Read Ch1
Read Ch2
204
defocus detector
defocus error
206
focus operator
205
servo controller

FIG. 3

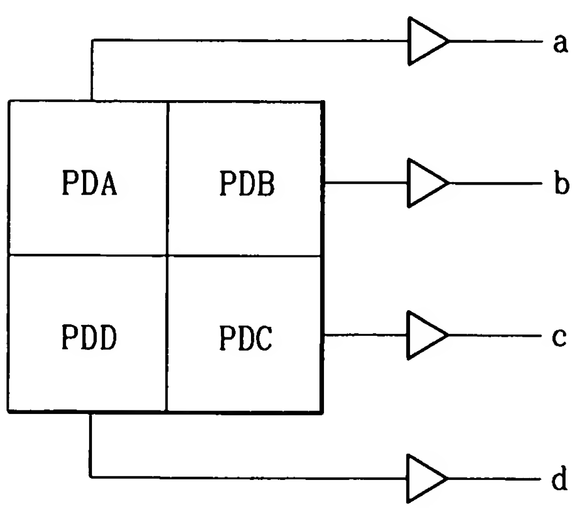
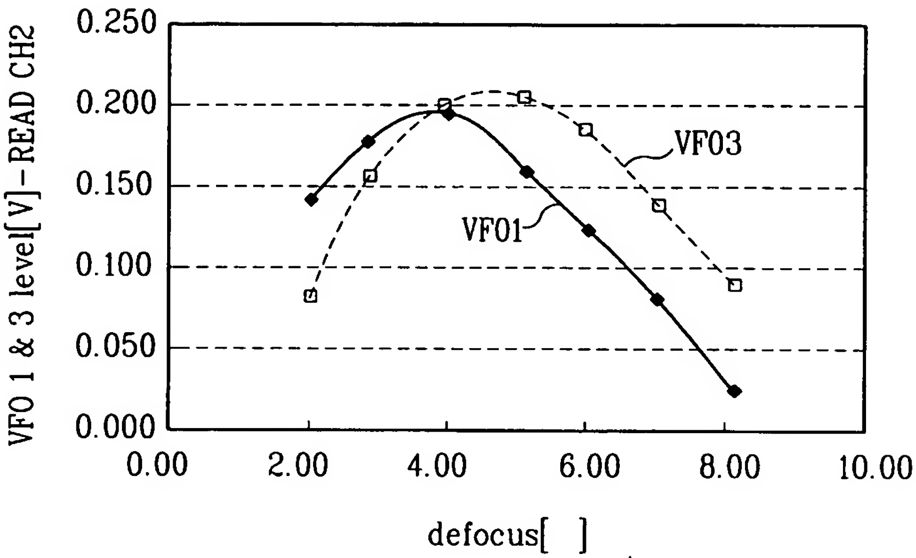
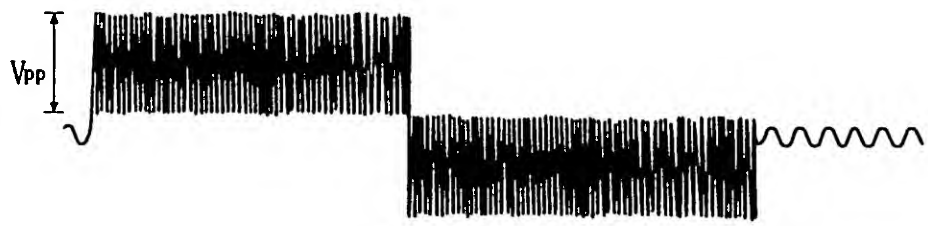

PDA
PDB
PDD
PDC
a
b
c
d

FIG. 4



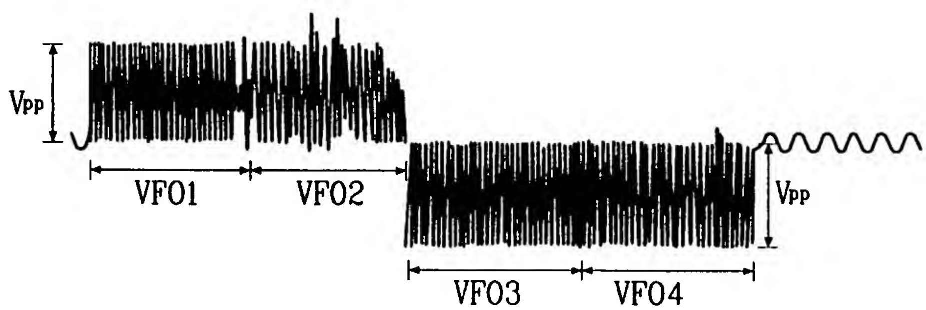
VFO 1 & 3 level[V]-READ CH2
0.250
0.200
0.150
0.100
0.050
0.000
0.00
2.00
4.00
6.00
8.00
10.00
defocus[ ]
VF03
VF01

FIG. 5a



tilt=0, detrack offset=4.97
defocus offset=2.0

FIG. 5b

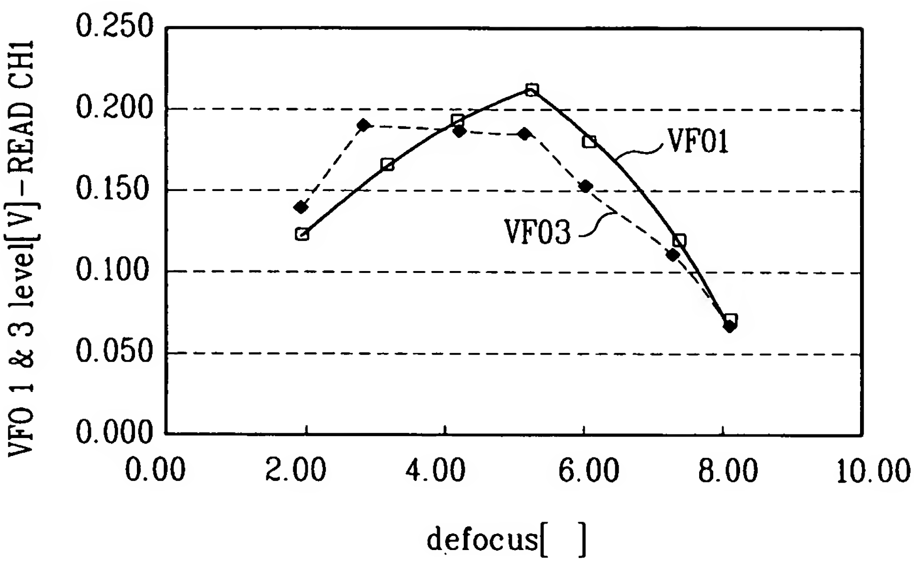


tilt=0, detrack offset=4.97
defocus offset=4.08

FIG. 5c

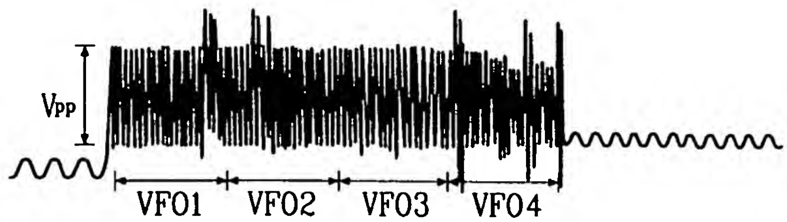
tilt=0, detrack offset=4.97
defocus offset=8.0

FIG. 6



VFO 1 & 3 level[V]-READ CH1
0.250
0.200
0.150
0.100
0.050
0.000
0.00
2.00
4.00
6.00
8.00
10.00
defocus[ ]
VF01
VF03

FIG. 7a

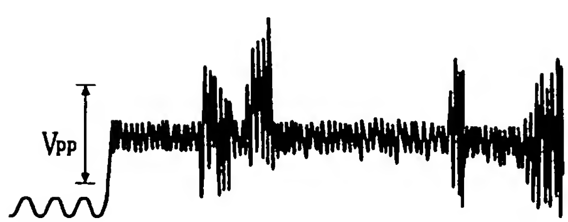


tilt=1, detrack offset=4.97
defocus offset=2.0

FIG. 7b

tilt=1, detrack offset=4.97
defocus offset=4.08

FIG. 7c



tilt=0, detrack offset=4.97
defocus offset=8.0

FIG. 8a

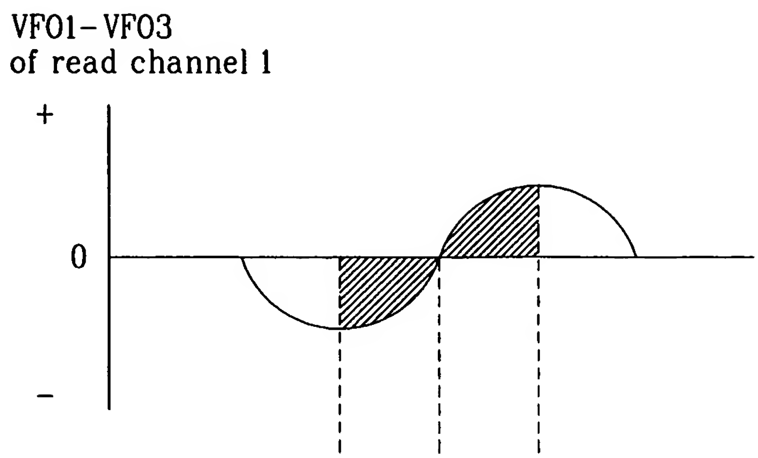
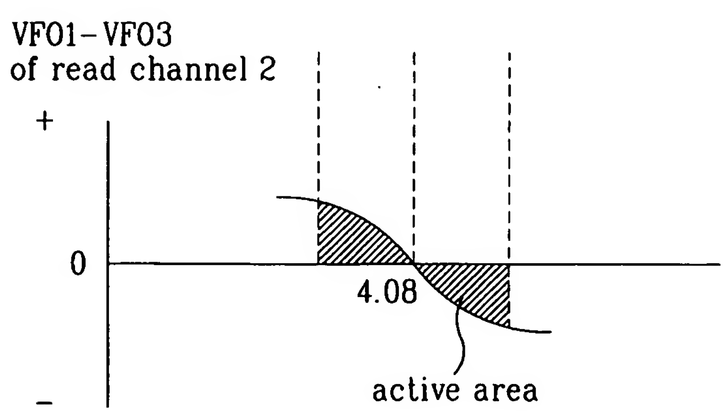

VFO1-VFO3
of read channel 1
+
0
−

FIG. 8b


VFO1-VFO3
of read channel 2
+
0
4.08
active area
−